

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
19 April 2001 (19.04.2001)

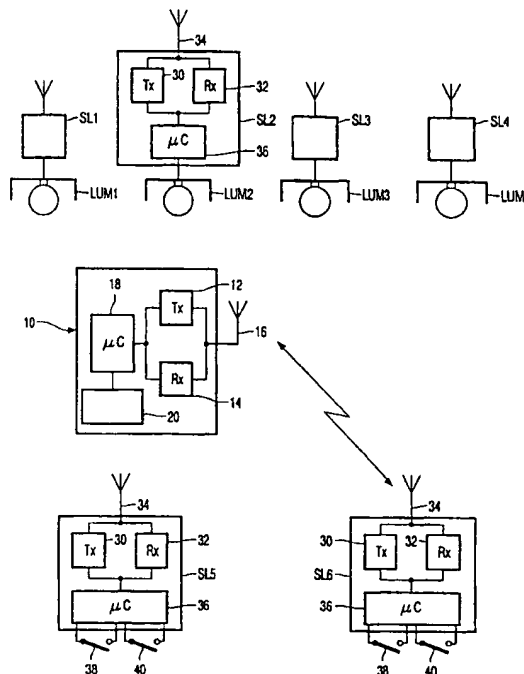
PCT

(10) International Publication Number  
**WO 01/28157 A2**

- (51) International Patent Classification<sup>7</sup>: **H04L 12/00** (72) Inventors: **JAMIESON, Philip, A.**; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **MARSDEN, Ian, A.**; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).
- (21) International Application Number: **PCT/EP00/09610**
- (22) International Filing Date:  
28 September 2000 (28.09.2000) (74) Agent: **WHITE, Andrew, G.**; Internationaal Octrooibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
9923864.4 9 October 1999 (09.10.1999) GB (81) Designated States (*national*): JP, KR.
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- Published:  
— Without international search report and to be republished upon receipt of that report.

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(54) Title: **LOW POWER RADIO NETWORK**



(57) Abstract: A low power radio network comprises a network responsible radio device (10) having a routing table (20) and a plurality of slave radio devices (SL1 to SL6) which have been enumerated by the network responsible radio device (10) as members of the network. A new slave device is enumerated by the slave radio device detecting the periodic reference signals transmitted by the network responsible radio device (10) and automatically initiating the enumeration process to become a member of the radio network. In the interests of network security the network responsible radio device is inhibited from accepting enabling requests unless it has been enabled by a user.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## DESCRIPTION

## LOW POWER RADIO NETWORK

## Technical Field

5           The present invention relates to a method of creating a low power radio network, to a radio network created by this method and to a slave radio device for use on the radio network.

          An application of the present invention is in the field of low power radio technologies for example home automation and personal local area networks.

## 10   Background Art

          Radio networks are known in the art and generally require devices to have built-in banks of settable dip switches. A radio address for a device is selected by adjusting the dip switches of the bank. Although the use of such devices has been known to provide operable networks they have some  
15   disadvantages. These disadvantages include the bank of user accessible dip switches increases the component count and hardware cost and limits the design packaging. A user needs to have knowledge of all the current devices on the network and their addresses so that the user can assign a new unused address to a new device. An error in setting the dip switches will only become  
20   apparent to the user when it is not working. Lastly, since anyone can set-up a device to work on a network, security is low.

## Disclosure of Invention

          An object of the present invention is to minimise user involvement in creating a low power radio network.

25           According to a first aspect of the present invention there is provided a method of enumerating a slave radio device on a low power radio network having a network responsible radio device, comprising the network responsible radio device transmitting periodic reference signals, and the slave radio device detecting the periodic reference signals and automatically initiating an  
30   enumeration process to become a member of the radio network.

          According to a second aspect of the present invention there is provided a low power radio network comprising a network responsible radio device and

a plurality of slave radio devices, each of the slave devices being enumerated by the network responsible device as members of the radio network.

The method in accordance with the present invention reduces user intervention when setting up a network thus allowing the network to be more dynamic in structure and also increasing the probability of a slave device working straight off the shelf.

According to a third aspect of the present invention there is provided a slave radio device for use on a low power radio network including a network responsible radio device, the slave radio device having means for detecting periodic reference signals transmitted by the network responsible radio device and means responsive to the detection of the periodic reference signals for initiating a network enumeration process to become a member of the radio network.

The setting-up of a radio network is dynamic in structure with both new slave devices coming on-line and other devices switching-off. The slave devices are simpler and cheaper as they do not require a bank of dip switches.

In order to maintain the integrity of the network, the network responsible radio device may have a default condition inhibiting acceptance of an enumeration request. This condition may be overcome by a user sending an enabling signal to the network responsible radio device.

#### Brief Description of Drawings

The present invention will now be described, by way of example, with reference to the accompanying drawings, wherein:

Figure 1 is a block schematic diagram of a radio network, and

Figure 2 is a diagram of the enumerating process between a master device and a slave device.

#### Mode for Carrying Out the Invention

The low power radio network shown in Figure 1 will for the sake of convenience be described with reference to a lighting system. However it is to be understood that the principles of the present invention can be applied to any other suitable application requiring low cost, low power consuming devices

operating over ranges of up to 50 metres, for example home automation, personal area networks.

Essentially the radio network comprises a star arrangement comprising a master radio device 10 functioning as a hub and low power radio slave devices SL1 to SL6 which are able to communicate with the master device 10 on a single channel in accordance with a carrier sense multiple access protocol. Such protocols are known and accordingly will not be described.

The master device 10, which may be powered from the mains supply, comprises a transmitter 12 and a receiver 14 coupled on the one hand to an antenna 16 and on the other hand to a microcontroller 18. A routing table 20 is coupled to the microcontroller 18 and in operation stores information about the radio network.

Each of the slave devices SL1 to SL6 is a low cost, battery powered device which comprises a transmitter 30 and a receiver 32 coupled on the one hand to an antenna 34 and on the other hand to a microcontroller 36. Those of the slave devices which function as remote controllers, say SL5 and SL6, have a simple, man/machine interface comprising say two switches 38, 40, voice activated devices or some other suitable signal input devices. The other of the slave devices, say SL1 to SL4, are coupled to apparatus to be controlled. In this example, the apparatus comprises luminaires LUM1 to LUM4.

The slave devices SL1 to SL6 have very small memories and have no knowledge about the radio network they become part of. Thus for example when a new slave device is to enter the radio network it has no prior knowledge of the network nor will it gain any knowledge about the network. Consequently it comprises a universal, off the shelf device which can join or leave any compatible radio network.

In order for a slave device to join a network it has to be enumerated by the master device. Enumeration is a process by which a slave device is given an identity by the master device 10.

In normal operation the master device 10 transmits periodic synchronisation or beacon signals. The synchronisation signals comprises

some information about the network for example if it is accepting new slave devices. An unenumerated (or orphaned) slave device will automatically start searching for a network to join and listen for the periodic synchronisation signals.

5        If the network is currently accepting new devices the orphaned device will transmit an "enumeration request". This gives the master device 10 enough information to make a first pass assessment on the orphaned device's suitability for the network (this is made possible by a "device type summary" which is included in the "enumeration request"). If the device is provisionally  
10        accepted at this stage it is issued dynamically with an address by the master device 10. The master device 10 will then request further "device summary information" this information takes the form of a predefined "Device Information Structure". Through interoperation of this information the master device 10 can make a more refined decision on the suitability of the orphaned slave  
15        device for the network and if acceptable it will join the network. Alternatively, if the orphaned slave device is considered unsuitable, the master device 10 will un-enumerate the orphaned slave device. As is evident the whole enumeration process has involved no user input at all. However to ensure network security and to allow the orphaned slave device to only join the correct  
20        network most networks by default will be set up not to allow new devices. Thus to enable a network for a new device to join, the user will need to actively enable the radio network for a new slave device. This can be achieved through a single button press on any of the remote control slave devices SL5, SL6 already on the network.

25        Optionally details of the enumerated device can include information about received signal strength at the master device 10, which information can provide an indication of range.

Figure 2 illustrates the exchange of signals between a master device 10 and an orphaned slave device OSL.

30        Signal 50 represents a periodic beacon (or synchronisation signal) transmitted by the master device 10. Signal 52 represents the device OSL requesting enumeration. Signal 54 represents the master device 10

acknowledging the request. Signal 56 represents the master device 10 requesting the device OSL to provide summary information. Signal 58 represents the device OSL supplying the information requested. Finally the signal 60 represents the device 10 acknowledging the signal 58 by either  
5 confirming the enumeration of the device OSL or un-enumerating it.

In the present specification and claims the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. Further, the word "comprising" does not exclude the presence of other elements or steps than those listed.

10 From reading the present disclosure, other modifications will be apparent to persons skilled in the art. Such modifications may involve other features which are already known in the design, manufacture and use of low power radio networks and component parts therefor and which may be used instead of or in addition to features already described herein.

15 **Industrial Applicability**

Low power radio networks such as home automation and personal local area networks.

## CLAIMS

1. A method of enumerating a slave radio device on a low power radio network having a network responsible radio device, comprising the  
5 network responsible radio device transmitting periodic reference signals, and the slave radio device detecting the periodic reference signals and automatically initiating an enumeration process to become a member of the radio network.

2. A method as claimed in claim 1, characterised in that the low  
10 power radio network has a default condition inhibiting new slave radio devices from becoming members of the radio network.

3. A method as claimed in claim 2, characterised in that the radio network is enabled to accept new slave devices by an already enumerated slave device transmitting a signal to the network responsible radio device.

15 4. A low power radio network comprising a network responsible radio device and a plurality of slave radio devices, each of the slave devices being enumerated by the network responsible device as members of the radio network.

5. A radio network as claimed in claim 4, characterised in that the  
20 network responsible radio device includes a routing table.

6. A slave radio device for use on a low power radio network including a network responsible radio device, the slave radio device having means for detecting periodic reference signals transmitted by the network responsible radio device and means responsive to the detection of the periodic  
25 reference signals for initiating a network enumeration process to become a member of the radio network.

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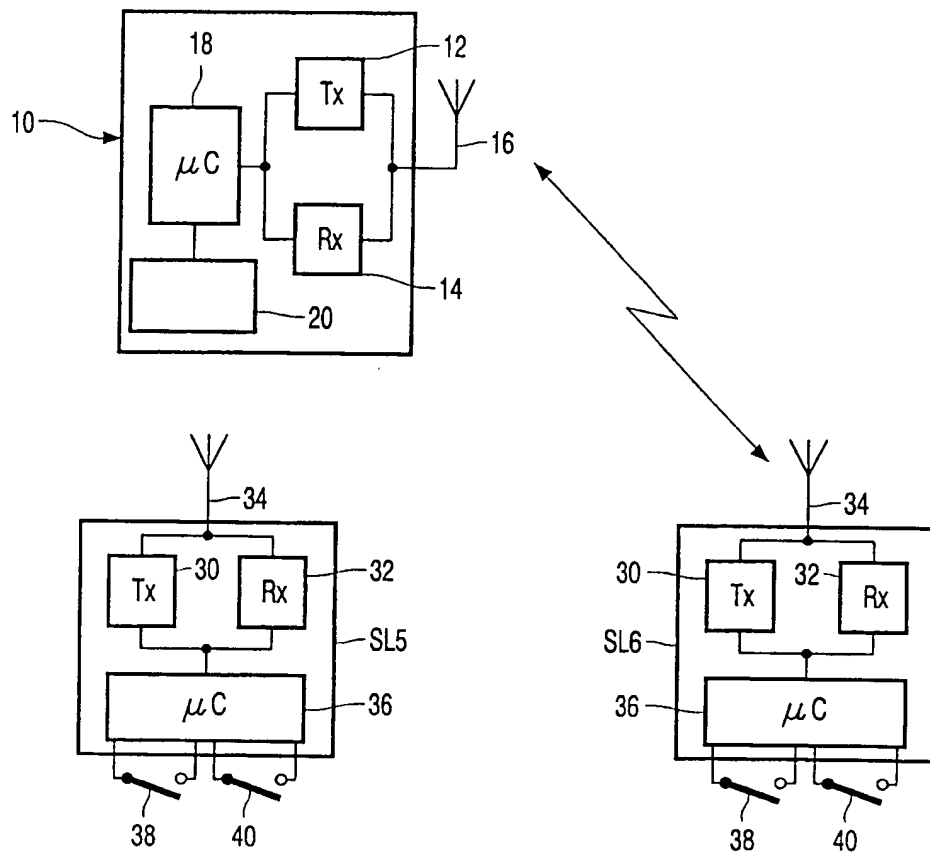
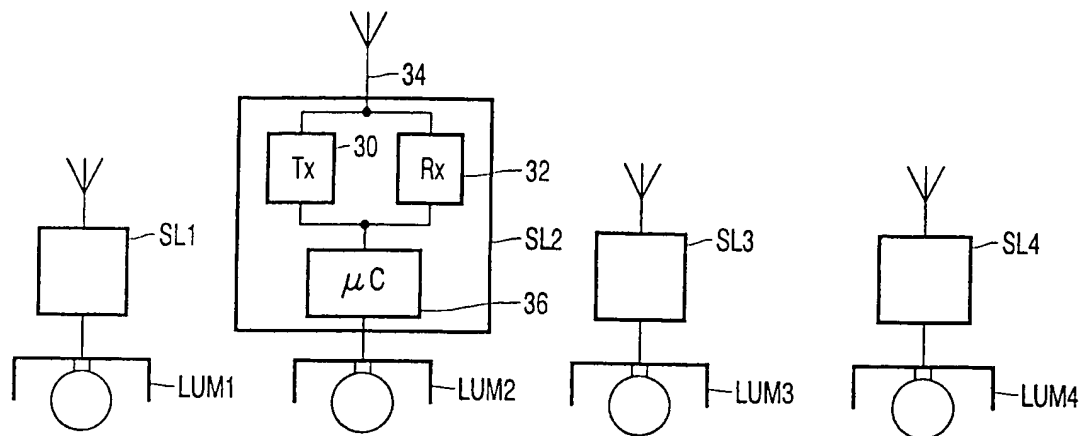


FIG. 1

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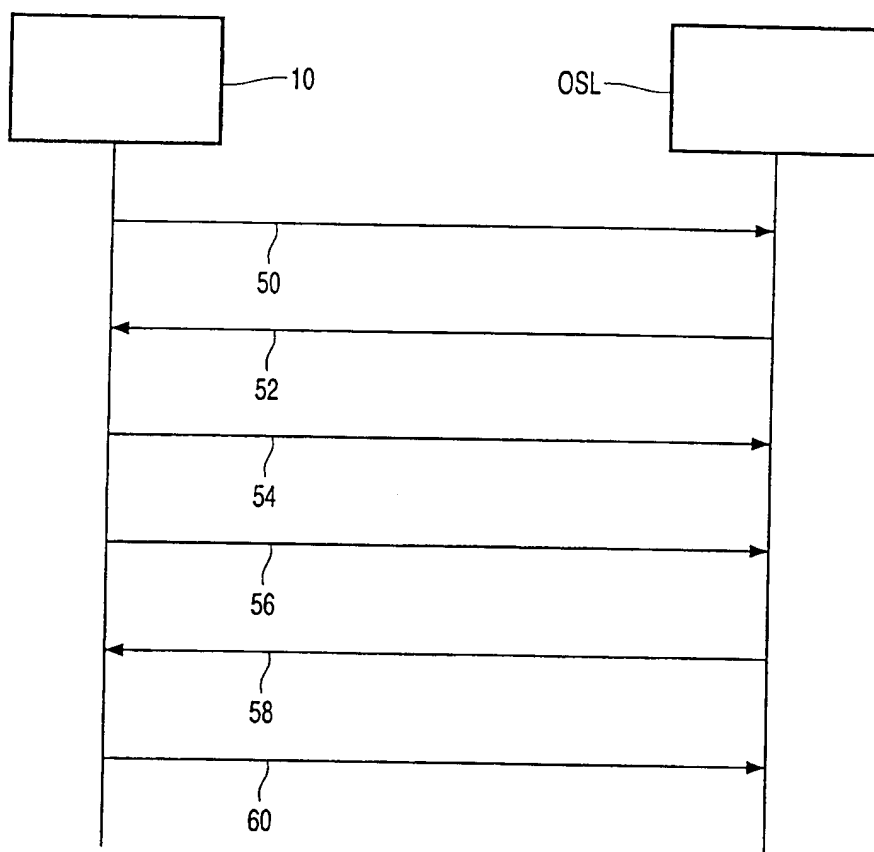


FIG. 2